



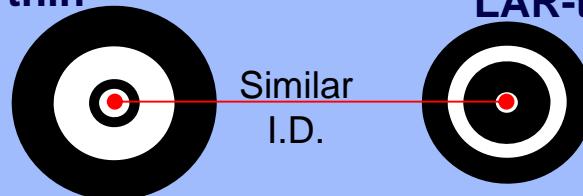
# Culmination of Coaxial Injector Mixing Studies:

Ivett Leyva, Doug Talley, Juan Rodriguez, Sophonias Teshome, Dustin Davis



Large Area Ratio-thin post

LAR-thin



LAR-thick

Small Area Ratio-thin post

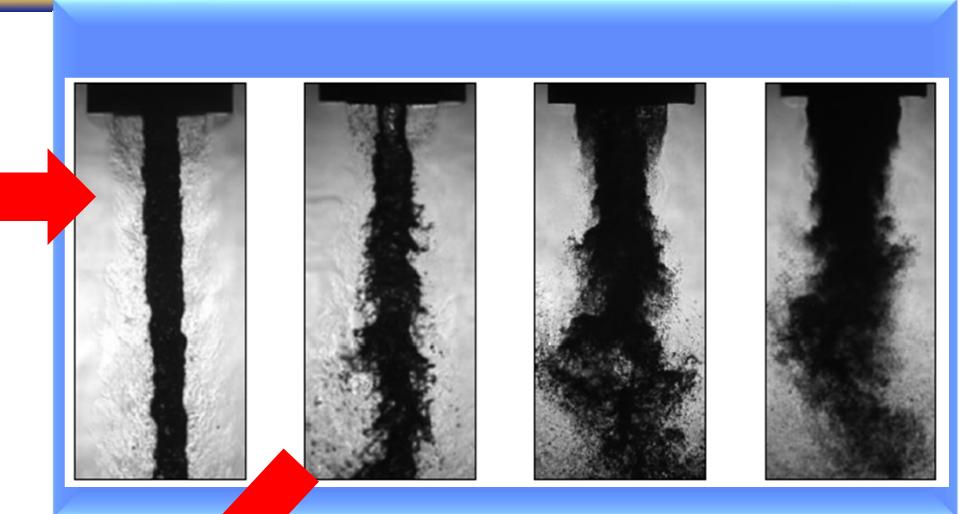


SAR-thin

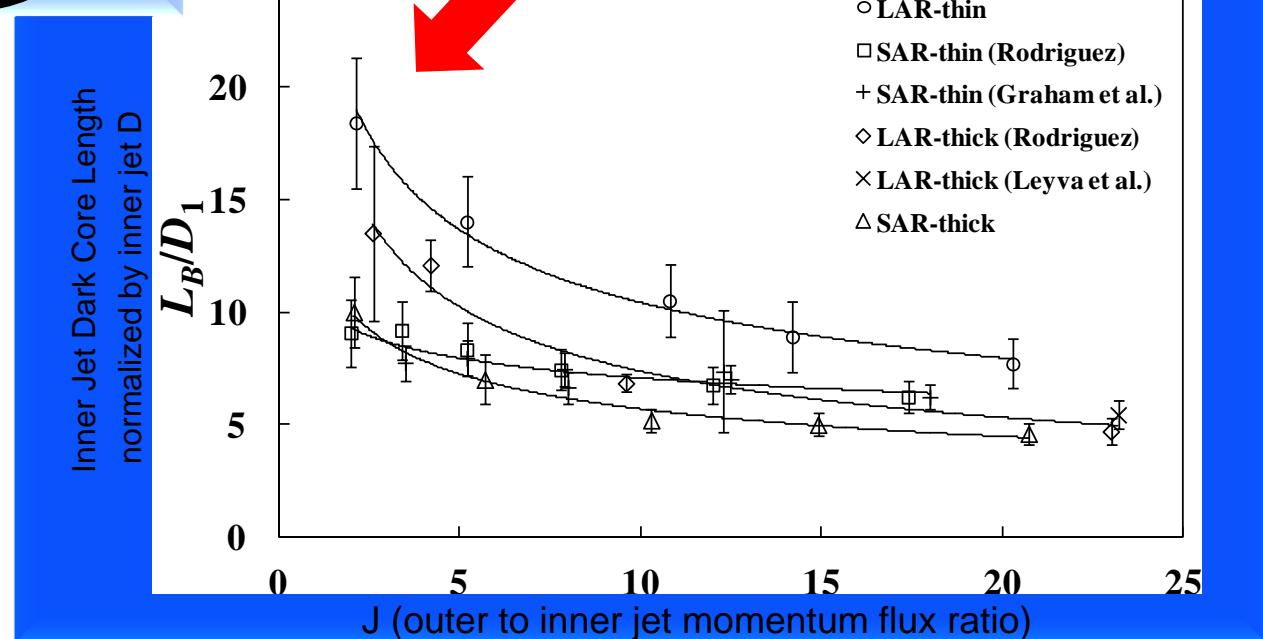
SAR-thick

Similar I.D.

Ref dimension  
6.4 mm



- **4 geometries**
- **Wide range of operating conditions**
- **With and without acoustic perturbations**



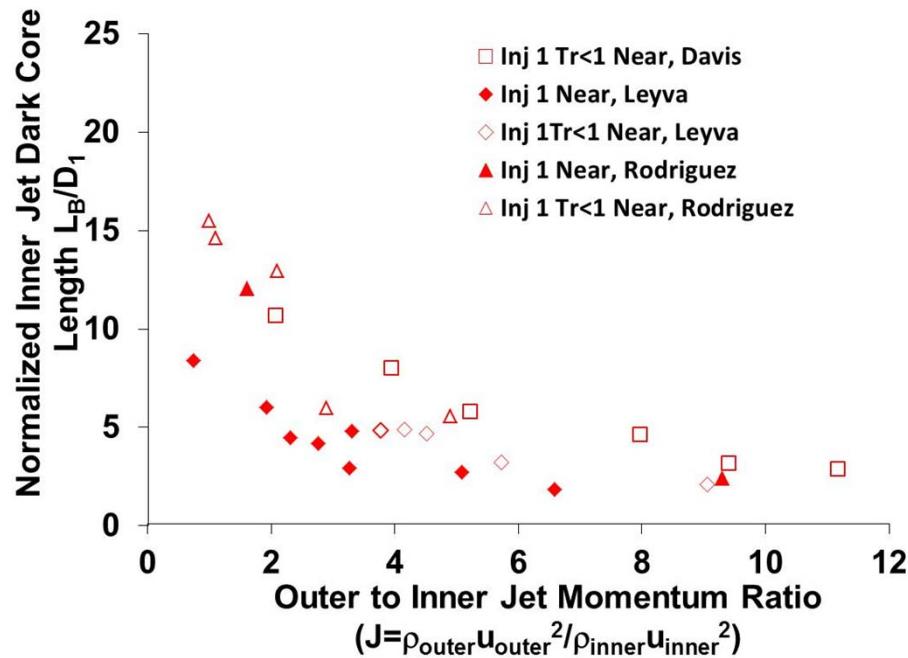
<b>Report Documentation Page</b>			Form Approved OMB No. 0704-0188	
<p>Public reporting burden for the collection of information is estimated to average 1 hour per response, including the time for reviewing instructions, searching existing data sources, gathering and maintaining the data needed, and completing and reviewing the collection of information. Send comments regarding this burden estimate or any other aspect of this collection of information, including suggestions for reducing this burden, to Washington Headquarters Services, Directorate for Information Operations and Reports, 1215 Jefferson Davis Highway, Suite 1204, Arlington VA 22202-4302. Respondents should be aware that notwithstanding any other provision of law, no person shall be subject to a penalty for failing to comply with a collection of information if it does not display a currently valid OMB control number.</p>				
1. REPORT DATE <b>SEP 2012</b>	2. REPORT TYPE	3. DATES COVERED <b>00-00-2012 to 00-00-2012</b>		
4. TITLE AND SUBTITLE <b>Culmination of Coaxial Injector Mixing Studies</b>		5a. CONTRACT NUMBER		
		5b. GRANT NUMBER		
		5c. PROGRAM ELEMENT NUMBER		
6. AUTHOR(S)		5d. PROJECT NUMBER		
		5e. TASK NUMBER		
		5f. WORK UNIT NUMBER		
7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES) <b>Air Force Research Laboratory, Wright Patterson AFB, OH, 45433</b>		8. PERFORMING ORGANIZATION REPORT NUMBER		
9. SPONSORING/MONITORING AGENCY NAME(S) AND ADDRESS(ES)		10. SPONSOR/MONITOR'S ACRONYM(S)		
		11. SPONSOR/MONITOR'S REPORT NUMBER(S)		
12. DISTRIBUTION/AVAILABILITY STATEMENT <b>Approved for public release; distribution unlimited</b>				
13. SUPPLEMENTARY NOTES <b>Presented at the 2012 AFOSR Space Propulsion and Power Program Review held 10-13 September in Arlington, VA.</b>				
14. ABSTRACT				
15. SUBJECT TERMS				
16. SECURITY CLASSIFICATION OF:			17. LIMITATION OF ABSTRACT <b>Same as Report (SAR)</b>	18. NUMBER OF PAGES <b>4</b>
a. REPORT <b>unclassified</b>	b. ABSTRACT <b>unclassified</b>	c. THIS PAGE <b>unclassified</b>		



# One geometry – 3 researchers

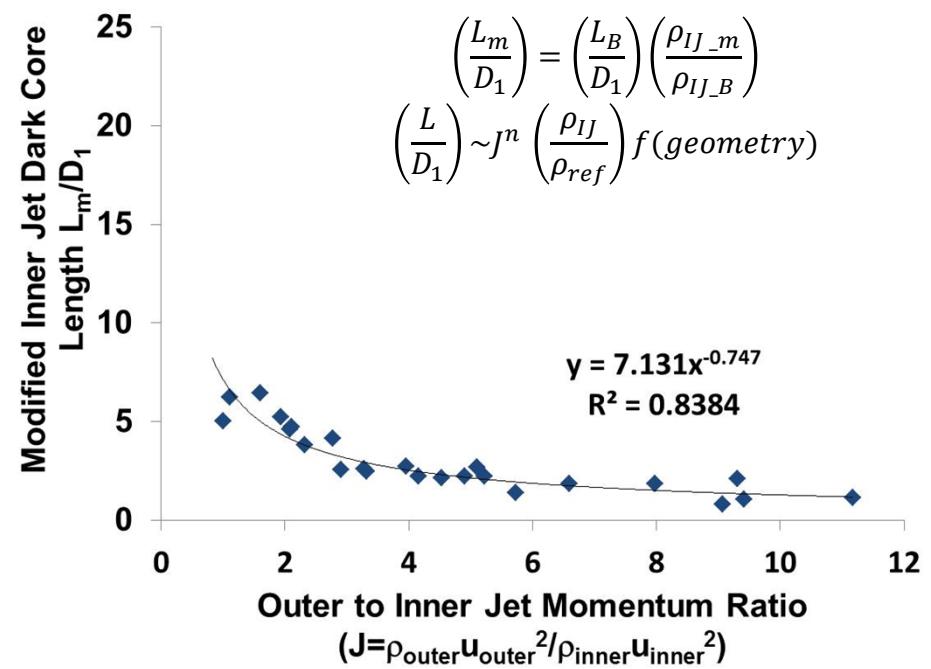


3 Researchers contributed to this baseline plot



Lots of scatter -- Why? Different inner jet densities

NEW --- Collapsed data!

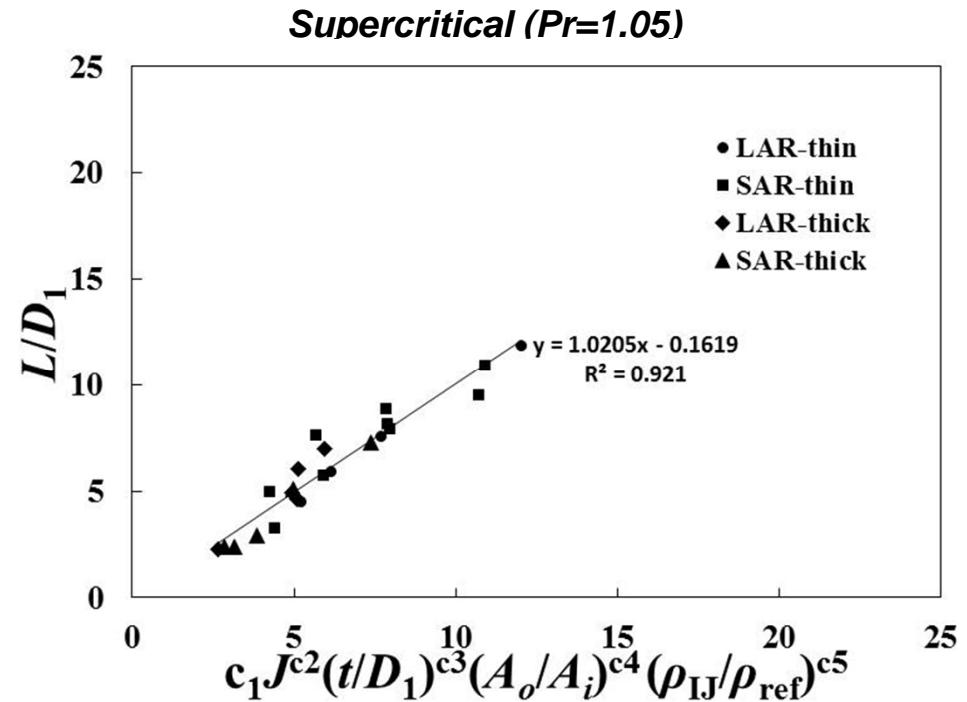
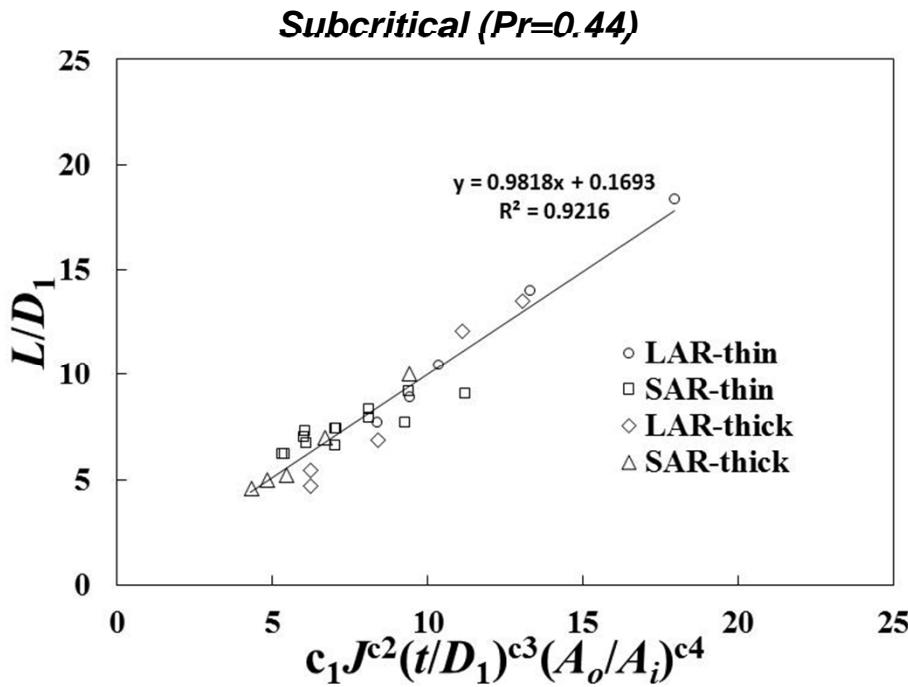


Mixing depends on more than just momentum flux ratio!!





# Adding geometry effects ...



- Has characterized mixing for shear coaxial injectors taking into account geometry and flow conditions!

$$\left(\frac{L}{D_1}\right) = c_1 J^{c_2} \left(\frac{t}{D_1}\right)^{c_3} \left(\frac{A_o}{A_i}\right)^{c_4} \left(\frac{\rho_{IJ}}{\rho_{ref}}\right)^{c_5}$$

$P_r$	$c_1$	$c_2$	$c_3$	$c_4$	$c_5$
0.44	9	-0.34	-0.15	0.30	
1.05	9	-0.40	-0.18	0.10	0.51





# Other Conclusions



- Outer to inner jet momentum flux ratio ( $J$ ) is not the only parameter to characterize mixing in shear coaxial jets - area ratio ( $A_o/A_i$ ), inner jet post thickness ( $t$ ), and reduced densities matter!
  - Found functional correlations for dark core lengths
- Based on four geometries, mixing is enhanced with increasing  $J$  and inner jet post thickness but less efficient with increasing  $A_o/A_i$
- Through LES we found relevant St numbers for one geometry for different  $J$  values
- Helical instabilities were observed for LAR-thin and SAR-thick, SAR-thin geometries at large  $J$  for baseline conditions
- Applying POD analysis for baseline and acoustically excited cases, able to discern stability characteristics for the different geometries for a wide range of flow conditions

